July 10, 1962 L. L. RECTOR 3,043,371

VALVED TUBING HANGER

Filed July 14, 1959 2 Sheets-Sheet 1

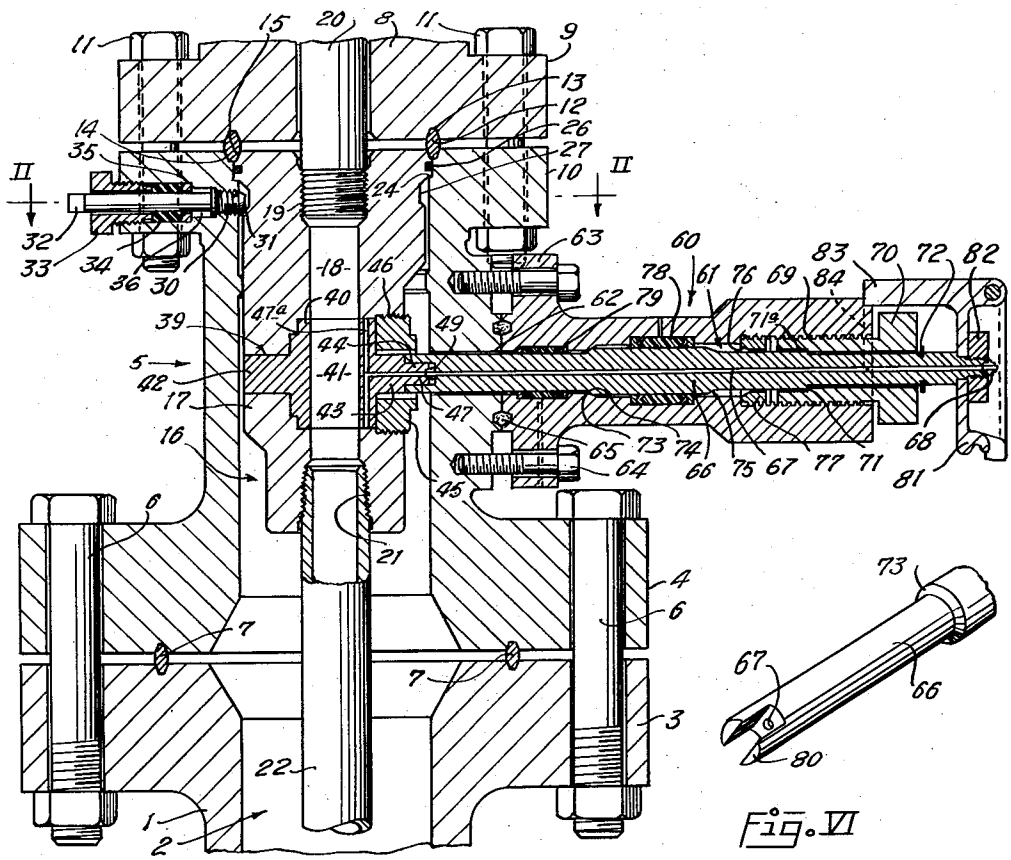

Fig. I

Fig. VI

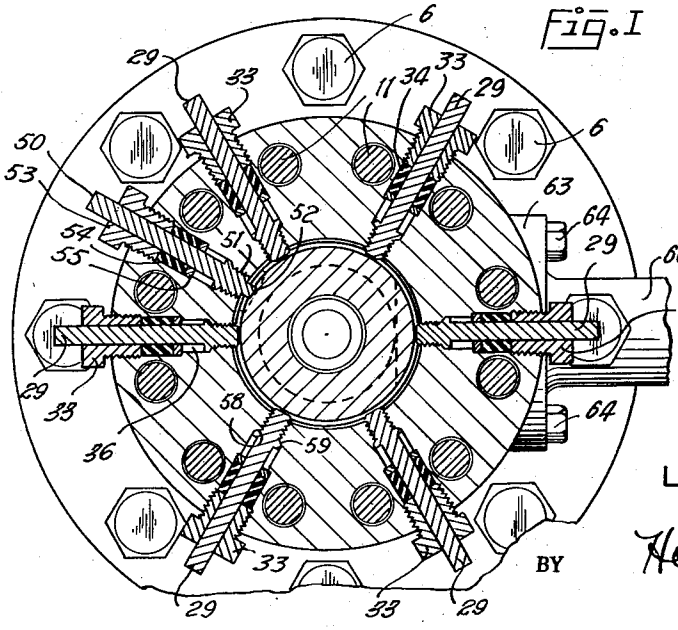

Fig. II

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VALVED TUBING HANGER

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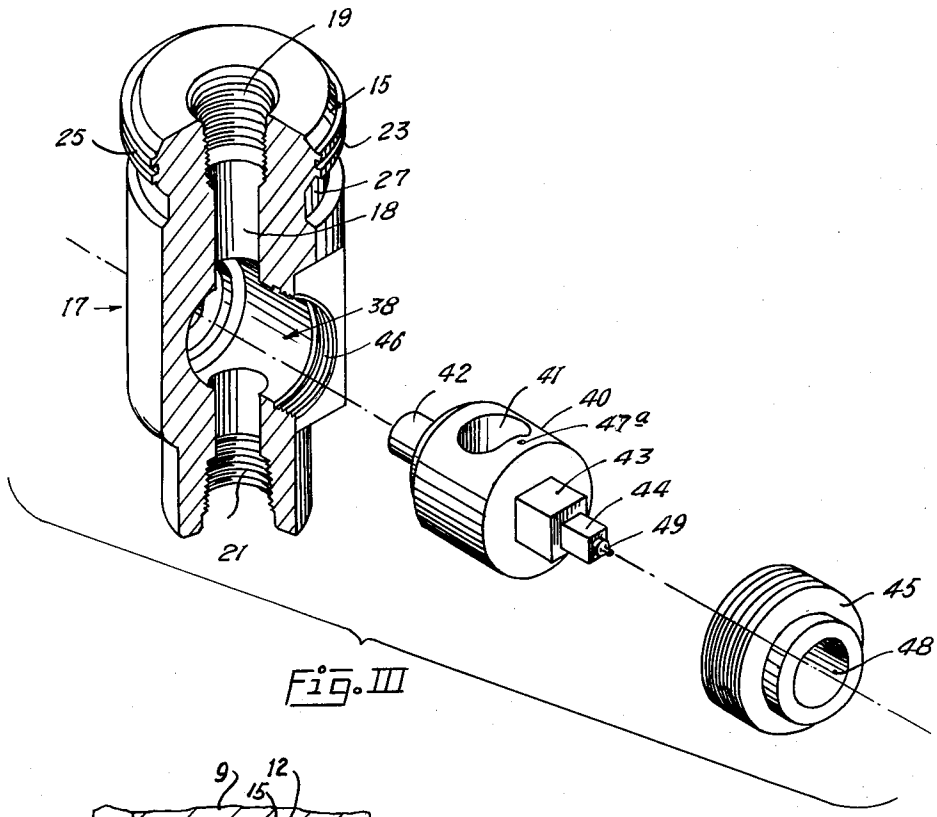

Fig. III

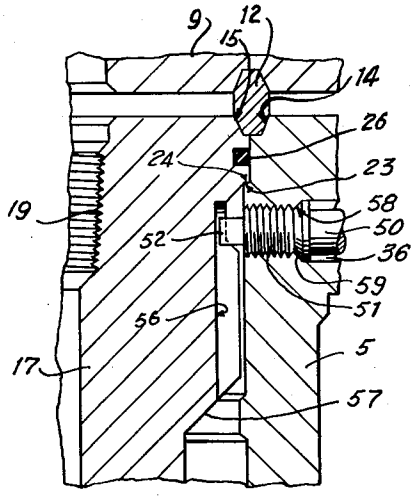

Fig. IV

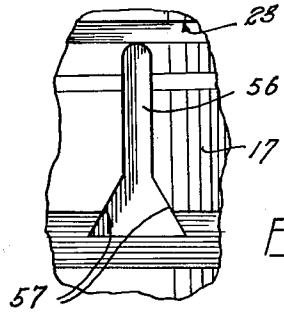

Fig. V

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3,043,371

VALVED TUBING HANGER

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Filed July 14, 1959, Ser. No. 827,034
5 Claims. (Cl. 166—86)

This invention is concerned wtih a tubing hanger for oil or gas wells and is particularly concerned with a tubing hanger of the type having a valve therein arranged to close the bore therethrough, which valve is operable from the outside of the tubing head.

The invention comprehends a hanger body suspended on an annular shoulder in the tubing head, and having a plug valve therein which may be rotated to open and close the bore through the body by means of a shaft or stem rotatably extending through the wall of the tubing head. The rotatable shaft is arranged to be inwardly and outwardly movable into and out of engagement with the valve body so that the stem may be retracted out of engagement with the valve body, and out of the bore of the tubing head, to thereby permit the hanger body to be removed from the tubing head and provide a full open bore in the tubing head when removed.

Such a valved tubing hanger is advantageous and useful in the event of fire or the accidental breaking of a surface connection, or a surface line, which would normally permit the well fluid under pressure to escape.

The valved tubing hanger permits the well to be quickly closed in the event of such emergencies, and also permits the well to be closed for the purposes of changing the surface connections or replacing damaged valves or parts on the well head above the tubing head.

The utilization of the control valve in the tubing hanger also permits safe operation during the completion of the well, and especially during the hazardous period when the blowout preventers are being removed and the "Christmas tree" assembly is being installed. The valve device will also assure positive control while seating or unseating packers down the hole.

One of the particular problems involved in the use of such a valved tubing hanger, having a retractable operating stem therefor, is the difficulty of aligning the operating stem with the engaging portion of the valve body, both vertically and circumferentially.

Tubing hangers having customarily been suspended in the tubing head on complementary tapered shoulders provided in the tubing head bore and on the hanger body. Such tapered shoulders do not provide for an accurate alignment and positioning of the tubing hanger vertically within the tubing head and are therefore unsatisfactory for use with a valved tubing hanger and retractable operating stem like that disclosed herein.

It has been found that such tapered shoulders are subject to wear and distortion after repeated use, and even if the operating stem were initially aligned with the engaging portion of the valve body, such would not remain the case because of the wear and distortion of the engaging tapered surfaces by repeated removal and replacement of the hanger. Furthermore the vertical position of the tubing hanger, suspended on tapered shoulders, varies with the load suspended thereto so that upon increasing the load suspended to the tubing hanger, the engaging portion of the valve body would move out of alignment with the operating stem.

A further problem is presented in that close tolerances must be followed in machining tapered seats, thus rendering it difficult to machine the tapered shoulders sufficiently exact to allow the retractable valve stem to be in position to freely engage the valve body.

Another problem present in the use of such a valved tubing hanger is that provision must be made for aligning the coinciding halves of the sealing groove about the upper surface of the tubing head and the hanger body so that a seal may be assured.

Still another problem in the use of such a valved tubing hanger is the necessity to align the engaging portion of the valve body with the engaging end of the retractable operating stem circumferentially or rotationally with reference to the tubing head bore.

An additional problem involved in the use of such a valved tubing hanger with retractable operating stem is the difficulty, if not impossibility, of moving the valve operating stem inwardly into engagement with the valve body against pressure existent in the well casing.

Applicant has overcome the above recited problems and attained the following objects with the present invention by:

(1) Suspending the tubing hanger on corresponding annular square shoulders in the tubing head bore and on the hanger body so that the engaging portion of the valve body is positioned in a predetermined vertical alignment with the engaging end of the retractable operating stem, and such alignment will be maintained regardless of the number of times the tubing hanger is removed from and replaced in the tubing head, and regardless of the weight suspended on the tubing hanger.

(2) Such coinciding square shoulders also provide for the exact alignment of the complementary parts of the sealing groove about the upper faces of the tubing head body and the tubing hanger so that a secure permanent seal is attained between the adapter flange and the upper face of the tubing head and the tubing hanger.

(3) As the tubing hanger is landed on the coinciding square shoulders, the engaging end of the retractable valve stem is also aligned circumferentially with relation to the engaging portion of the valve body by a guide pin extending through the wall of the tubing head and a vertical guide slot formed in the outer surface of the tubing hanger. Similar vertically slidable key arrangements between hanger body and the hanger would accomplish the same purpose.

(4) Thus when the tubing hanger is landed in the tubing head the engaging portion of the valve body is in alignment with the engagine end of the operating stem, and is maintained in such position regardless of the weight imposed upon the tubing hanger and the number of times the tubing hanger is removed and reinserted in the tubing head.

(5) The square coinciding suspension shoulders also correctly positions and spaces the temporary resilient seal between the tubing head wall and the tubing head hanger until the permanent seal is secured in place.

(6) The operating stem is positively moved inwardly against pressure in the well casing by a threaded connection comprised of a drive nut threadedly engaged in the outer edge of the housing for the operating stem.

(7) Positive means is provided for limiting the inward and outward movement of the operating stem, so that there is no possibility of the operating stem becoming jammed in the housing therefor.

(8) Positive means is provided for holding the tubing hanger downwardly against pressure in the well so as to maintain alignment of the operating stem with the engaging portion of the valve member.

(9) Hold down pins and guide pins are provided with tapered seating surfaces which cooperate with coinciding tapered seating surfaces in the bores through which they extend so that a metal to metal seal is provided, thereby permitting resilient sealing elements thereabout to be replaced under pressure.

Other and further objects, in addition to those hereinbefore recited, are attained by my invention, as will be-

come apparent upon reading the detailed specification hereinafter following and by referring to the drawings annexed hereto.

A suitable embodiment of the invention is disclosed in the attached drawings in which:

FIGURE I is a cross-sectional, elevational view of a tubing head attached above a casing head, incorporating the novel valved tubing hanger and hanger suspension means, and showing the novel operating stem for the valve therein;

FIGURE II is a transverse, sectional view taken on the line II—II of FIGURE I;

FIGURE III is an expanded view, partially in section, showing the tubing hanger, valve body and follower ring for securing the valve body in place in the transverse bore of the tubing hanger;

FIGURE IV is an enlarged fragmentary, elevational, cross-sectional view showing the vertical suspension and lateral aligning pin and slot arrangement for aligning the tubing hanger vertically and rotationally in the tubing head, and for aligning the halves of the groove extending about the upper face of the tubing hanger and the tubing head bodies;

FIGURE V is a fragmentary, side elevational view of the guide slot in the outer surface of the tubing hanger, which, in conjunction with the contractable guide pin extending through the wall of the tubing head, positions the tubing hanger circumferentially in the tubing head bore;

FIGURE VI is a fragmentary perspective view showing the inner end of the operating stem for the valve body, and showing the bifurcated end thereof which is engageable with the square engaging extension of the valve body.

Numeral references are employed to designate the various parts shown in the drawings, and like numerals indicate like parts throughout the various figures of the drawings.

The numeral 1 indicates a conventional casing head which is attached to the upper end of the wall casing (not shown) extending into an oil or gas well. Said casing head 1 has a cylindrical bore 2 therein and includes an annular flange 3 on the upper end thereof.

The flange 3 may be secured to a corresponding annular flange 4 on the tubing head 5, and the flanges are drawn together and secured in fixed relation to each other by means of bolts 6 which pass therethrough.

As the flanges 3 and 4 are drawn together by the bolts 6 the metal annular seal ring 7 is compressed into sealing engagement with corresponding annular grooves on the upper face of the casing head 1 and the lower face of the tubing head 5.

Attached to the upper end of the tubing head 5 is an adapter coupling 8, having an annular flange 9 thereon, which coincides with an annular flange 10 on the tubing head 5. The flanges 9 and 10 are secured together in fixed relationship by means of bolts 11 passing therethrough, and a seal is provided therebetween by a metal seal ring 12 which extends into a groove 13 on the lower face of the adapter coupling 8 and into a groove formed by a tapered surface 14 around the upper opening of the tubing head bore 16 and a tapered surface 15 formed about the upper, outer edge of the hanger body 17. The seal ring 12 provides a seal between the adapter coupling 8 and the upper face of the tubing head body 5, and also provides a seal between the tubing hanger 17 and the bore 16 of the tubing head 5.

The tubing hanger body 17 is generally cylindrical in outer configuration, and has a central bore 18 therethrough. There are interior threads 19 provided at the upper end of the bore 18 to which may be threadedly attached a section of pipe, or tubing 20, which in turn may be connected to surface connections (not shown). Interior threads 21 are provided in the lower end of the bore 18 to which may be threadedly attached a section of production tubing 22 extending into the well casing (not shown).

The hanger body 17 has formed thereon, near the upper end thereof, a substantially straight annular, downwardly facing shoulder 23, which is arranged to come to rest, and be suspended upon, a substantially straight coinciding annular shoulder 24, formed in the tubing head bore 16. The tubing hanger 17 may be thus suspended in the tubing head bore on such coinciding shoulders 23 and 24. When so positioned in the tubing head, the hanger body 17 is suspended in a fixed position vertically with relation to the tubing head, so that such position does not vary with the weight imposed upon the hanger, and does not substantially change by reason of wear between the shoulders.

When so suspended on the straight shoulders 23 and 24, it will be seen that the tapered surfaces 14 and 15 on the tubing head and on the tubing hanger, provide the seal groove about the upper faces thereof, which are positioned in accurate coinciding alignment so that when the seal ring 12 is positioned therein and pressed between the adapter coupling 8 and the tubing head 5 and hanger 17, a secure and effective seal will be attained.

Heretofore, it has been difficult to assure an effective seal between a seal ring and coinciding groove sections on the hanger and on the tubing head, because, due to added weight on the hanger, the hanger would often recede into the head on the tapered shoulders to such an extent as to cause the groove sections to be out of alignment. The coinciding square suspension shoulders 23 and 24 positively prevent such occurrence.

A peripheral seal groove 25 is provided about the upper end of the hanger body 17, and such seal groove 25 is arranged to receive a resilient O-ring seal 26. The O-ring seal 26 provides a temporary seal between the tubing head bore 16 and the hanger body 17 until the permanent seal ring 12 is pressed into sealing engagement. The straight shoulders 23 and 24 also assure that the temporary seal rings 26 are in proper lateral alignment with the surface on the inner bore of the tubing head to provide a seal.

A peripheral hold-down groove 27 is provided about the upper end of the hanger body 17, and below the coinciding shoulders 23 and 24.

A plurality of hold-down pins 29 extend through the flange 10 of the tubing head body 5 and are retractable therein by virtue of the threads 30 thereon which cooperate with companion threads arranged in the wall of the tubing head body. The inner ends 31 of the hold down pins 29 are arranged to engage the lower edge of the groove 27 and thereby hold the hanger body 17 against upward movement in the tubing head by reason of well pressure exerted therebelow. Thus the hold-down pins 29 maintain the square shoulders 23 and 24 in engagement, and hold the hanger 17 in fixed position in the tubing head against upward movement. Thereby such hold-down pins further assure that the engaging portion of the valve body in the hanger will be in alignment with the retractable operating stem for engagement therewith.

The hold-down pins 29 have flat wrench engaging surfaces 32 on the outer end thereof whereby they may be rotated for threading inwardly and outwardly of the bore 16 of the tubing head 5.

A compressible seal 34 is provided in the bore, or opening 36, through which the hold-down pins extend. Said resilient seal 34 may be compressed into sealing engagement with the wall of such bore 36 by means of a threaded gland 33 which may be threaded inwardly against the seal 34. The seal 34 is expanded against a support ring 35 in said bore, as it is compressed by gland 33.

A transverse bore 38 is provided in the hanger body 17, said bore 38 intersecting the axial bore 18 therethrough.

The transverse bore 38 includes a reduced bearing opening 39 in the wall of the body 17, and a threaded opening 46 in the wall of the body 17.

The cylindrical valve body 40 is arranged to be in-

serted in the transverse bore 38 and is rotatable therein on the cylindrical bearing portion 42 thereon, which rotatably extends through the bearing opening 39.

The valve body 40 also includes a circular passage 41 extending transversely therethrough, which passage 41 is of substantially the same diameter as the axial bore 18 in the tubing hanger body 17. The passage 41 is arranged to coincide with such bore 18 when the valve body 40 is rotated to open position. When rotated 90° from such position, the solid sides of the valve body 40 close the bore 18, closing the bore 18 to the flow of fluid therethrough.

The valve body 40 includes a reduced extension 43 thereon, which, as shown, is square in contour but, of course, could be of any desired shape with flat surfaces for engagement with stem 66. The reduced square engaging portion 44 of the valve body 40 is arranged to extend outwardly in position to be engaged by the bifurcated end 80 of the operating stem 66.

The valve 40 is held and maintained in the transverse bore 38 by means of a threaded follower ring 45 which is arranged to be threadedly engaged with the threads 46. The bore 48 in the follower ring 45 is arranged to pass over the extension 43 and such extension 43 is rotatable in the bore 48.

Lubricating passages 47 and 47*a* are provided in the valve body 40 so that the valve body may be supplied with liquid lubrication through the lubrication fitting 19.

The hanger body 17 may be positioned circumferentially with reference to the bore 16 by means of a locator pin 50 which threadedly extends through a passage 36 provided through the wall of the tubing head body on the companion threads 51. The locator pin 50 includes an engaging end 52 which is arranged to extend into the guide slot 56 formed in the outer face of the hanger body 17.

A resilient packing ring 54 is compressed and sealed between the locator pin 50 and the wall of the bore 36 by means of a threaded compression gland 53, which forces and expands the resilient packing ring 54 against the back-up ring 55.

An important feature of both the locator pin 50 and the hold-down pins 29 is that the seal rings 34 and 54 may be replaced while the well is under pressure, due to the fact that a metal to metal seal is provided between the tapered seat 58 in the bore 36 and the corresponding tapered shoulder on the pins 29 and 50. When the pins 29 and 50 are screwed inwardly the shoulders 58 and 59 seat and seal so that the glands 33 and 53 may be removed for replacement of seal rings 34 and 54 without allowing escape of pressure from the tubing head.

The hanger body 17 may be positioned in a desired fixed circumferential position, and secured against rotation, in the tubing head bore 16, by guiding the slot 56 over the engaging end 52 of the locator pin 50. The locator pin 50 is guided into the slot 56 by engagement with the beveled guide surfaces 57 as the hanger is lowered into the bore 16. By virtue of the predetermined relative positions of the locator pin 50 and the guide slot 56 the engaging portion 44 of the valve body 40 may be aligned circumferentially with relation to the engaging end 80 of the operating shaft 66.

The locator pin 50 and slot 56, in conjunction with the mating square shoulders 23 and 24, aligns and positions hanger body 17 both vertically and rotationally in bore 16 so that the engaging end of operating shaft 66 is aligned, and maintained in alignment, with the engaging portion 44 of the valve body 40.

The housing 60 for the valve operating shaft 66 includes a substantially circular bore 61 therethrough which coincides with a circular bore 62 extending through the wall of the tubing head body 5.

The housing 60 includes an annular flange 63 which is secured to the tubing head body 5 by means of machine screws 64 and is sealed thereto by the resilient octagonal seals 65, which extend into coinciding grooves in the end of the housing 60 and on the outer face of the tubing head body 5.

The operating shaft 66 for the valve body 40 includes a longitudinal lubrication passage 67 therethrough through which liquid lubrication may be injected through a standard lubrication fitting 68. The valve body 40 may thus be lubricated from the outer end of the operating stem 66 through the passage 67, lubricating fitting 49 and passages 47 and 47*a*. The outer end of fitting 49 extend into the inner end of passage 67, when stem 66 is in inward position, as shown in FIGURE I.

The operating stem 66 may be moved inwardly and outwardly in the housing 60 for engagement with, and disengagement from, the valve body 40 by means of a drive nut 69 threaded into the outer end of the bore 61 of the housing.

The drive nut 69 has a wrench engaging head 70 thereon by which it may be engaged for rotative movement inwardly and outwardly of the housing 60.

Corresponding engaging shoulders 71 and 71*a* on the drive nut 69 and the operating stem 66 cause the operating stem 66 to move inwardly with the drive nut 69. The snap ring 72, which is disposed in a peripheral groove in the outer surface of the operating stem 66, engages the outer end of the drive nut 69, to thereby cause the stem 66 to move outwardly with the drive nut 69.

A tapered shoulder 73 is provided on the stem 66, which is arranged to come into engagement with a corresponding tapered shoulder 74 in the bore 61 to limit the inward movement of the stem 66 in the bore 61.

A tapered shoulder 75 is provided on the stem 66 which is arranged to come into engagement with a corresponding tapered shoulder 76 on the adjustable threaded ring 77 to limit the outward movement of the stem 66 in the bore 61.

Suitable sealing material 78 and 79 is provided in the bore 61 to slidably seal about the stem 66 as it moves inwardly and outwardly. Such sealing material may be of the plastic type or it may be rubber or plastic composition.

The stem 66 has a bifurcated end 80 thereon which is arranged to engage with the square extension 44 on the valve body 40, when the stem 66 is moved inwardly by the drive nut 69. After the stem 66 has been moved inwardly into engagement with the valve body 40, as shown in FIGURE I, the operating stem 66 may be rotated by the operating handle 81, to thereby rotate the valve body 40, and bring the transverse passage 41 therein into alignment with the bore 18 to permit flow of fluid through the hanger body 17. The valve body 40 may also be rotated 90° from the position shown in FIGURE I, to bring the solid sides of the valve body 40 into alignment with the bore 18 to thereby prevent the flow of fluid through the hanger body 17.

A disengageable attachment could be provided, if desired, between the stem 66 and the valve body 40, as by a J slot or bayonet type joint connection which may be engaged and disengaged by rotation of stem 66.

An operating handle 81 is secured to the stem 66 by means of a nut 82 threaded thereon. The valve body 40 is limited in rotation to full-open and full-closed position by means of a slot 84 provided on the end face of the housing 60 into which extends a lug or extension 83 provided as a part of the operating handle 81. The lug, or extension 83, is arranged to engage one end of the slot 84 when the valve body 40 is rotated to a position to align the opening 41 with the bore 18, and the lug 83 is arranged to engage the other end of the slot 84 when the valve body has been rotated to a position where the solid sides of the valve body 40 close the bore 18.

The operation and function of the device hereinbefore described is as follows:

The casing head 1 and tubing head 5 are assembled in the position shown in FIGURE I. The hold-down pins 29, locator pin 50 and the operating stem 66 are retracted

so that the ends thereof are out of the bore of the tubing head to provide a substantially full open bore in the tubing head while tubing and apparatus attached thereto is being run into the well. The locator pin 50 is rotated so that the engaging ends thereof extends into the bore of the tubing head after the tubing has been run and it is desired to place the tubing hanger 17 thereon and suspend same in the tubing head. The tubing hanger 17 is then attached to the upper joint of the production tubing 22 and is positioned so that the slot 56 may be guided over the locator pin 50. The tubing hanger 17 is then lowered into the tubing head bore until the straight shoulders 23 and 24 coincide. Thus the tubing hanger 17 is suspended in the head in a fixed and pre-determined position, and in such position the engaging portion 44 of the valve body is in alignment with the stem 66 so that the stem may be engaged therewith. The hold-down pins 29 are then turned inwardly to engage the groove 27. The adapter coupling 8 is then secured in place on the tubing head, with the seals 12 sealingly engaged between the tubing head and the coupling 8.

When it is desired to operate the valve body 40 to either open or close the bore 18, the operating stem 66 may be moved inwardly by rotating the drive nut 69 until the end 80 thereof extends over and engages with extension 44. The stem may then be rotated to rotate the valve body 40 to the position desired.

The drive nut 69 permits the stem 66 to be easily moved inwardly against pressure in the well, which would be difficult, if not impossible, without such positive means of movement. Other positive means for moving stem 66 inwardly against pressure could, of course, be provided such as hydraulic means.

The drive nut 69 also serves to maintain the stem 66 inwardly in engagement with valve body 40 against pressure in the well, in the event it is desired to leave the stem connected to the valve body while the well is on production.

It will thus be seen that I have provided improvements in a valved tubing hanger which may be opened and closed by manipulation exteriorly of the tubing head wherein it is assured that the operating stem for the valve is initially placed in alignment for engagement with the valve body, and remains in such alignment at all times, regardless of the weight imposed on the tubing hanger, and regardless of the number of times the tubing hanger is removed and replaced in the tubing head.

I have also provided means for assuring a positive seal between the tubing hanger and the tubing head, and between such members and the adapter coupling. Further there has been provided means to assure that the operating stem for the valve can be positively moved inwardly against pressure in the well, when it is desired to engage same with the valve body, and to maintain the stem in inward position against pressure.

It will be understood that other and further modifications and devices for carrying out the invention may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In a device of the class described, a tubing head having an axial bore therethrough; an annular shoulder in the tubing head bore; a hanger body; an annular shoulder on the hanger body arranged to coincide with the shoulder in the bore; a guide member extending inwardly of the bore; a vertical slot in the outer surface of the hanger body arranged to slide over the guide member; a vertical passage in the hanger body; a valve member disposed in the passage, and arranged to open the passage in one position and close same in another position; a passage through the wall of the tubing head; a substantially tubular housing attached to the outer wall of the tubing head and having a bore therethrough coinciding with the passage through the wall of the tubing head; an operating stem slidably and rotatably disposed in the housing and through the wall of the tubing head, the said stem and valve member having detachable, inter-engageable parts whereby the stem may be moved into and out of engagement with the valve member; drive means arranged about the stem and threadedly engaged in the outer end of the housing; complementary shoulder means between the stem and the drive means to cause movement of the stem inwardly upon rotation of the drive means in one direction; and complementary shoulder means between the stem and the drive means to cause outward movement of the stem upon rotation of the drive means in the other direction.

2. The combination called for in claim 1 wherein the annular shoulder in the tubing head bore and on the hanger body are square.

3. The combination called for in claim 1 wherein there is complementary shoulder means between the housing and the stem to limit inward movement of the stem, and complementary shoulder means between the stem and the housing to limit outward movement of the stem.

4. The combination called for in claim 1 including a slot on the outer face of the housing; an operating handle on the stem, and means carried by the handle engageable with the ends of the slot in two positions of rotation to limit rotation of the stem.

5. A sub-combination comprising a tubing head; a passage through the wall of the tubing head; a tubular housing attached to the outer wall of the tubing head and having an axial bore therethrough coinciding with said passage; an operating stem slidably and rotatably extending through the bore and the passage; complementary shoulder means on the stem and in the housing to limit inward and outward movement of the stem; a drive member disposed about the stem and threadedly engaged in the bore; and complementary shoulder means between the stem and drive member for moving the stem inwardly and outwardly upon rotational movement of the drive member.

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